ORIGINAL ARTICLE

Testing the "Epidemiologic Paradox" of Birth Outcomes Among Asian Immigrant Women in Hsin-Chu County, Taiwan

Ching-Yun Liu,[1,2] *Nien-Tzu Chang,*[1] *Pesus Chou*[1]*

Background/Purpose: Taiwan saw an increase in immigration during the last decade. This retrospective study investigated whether immigrant status confers a protective effect on birth outcomes and whether this effect varies across racial/ethnic subgroups in Hsin-Chu County, Taiwan.

Methods: A total of 30,770 singleton birth certificates from January 1, 2002 to July 31, 2007 were analyzed using ANOVA and logistic regression. Outcomes included low birth weight (LBW, < 2500 g), high birth weight (HBW, > 4000 g), preterm birth (< 37 weeks) and stillbirth. Covariates included maternal age, year of delivery, mode of delivery, medical care institution, infant sex and congenital birth defects. Five models were designed for various analyses. The reference categories included non-immigrant, non-aboriginal Taiwanese and non-Chinese-speaking immigrants.

Results: Preterm rate ranged from 6.3% among mainland Chinese to 13.5% among aboriginal Taiwanese. LBW rate ranged from 4.3% among mainland Chinese to 17.3% among aboriginal Taiwanese. HBW rate ranged from 1.2% among aboriginal Taiwanese to 3.4% among mainland Chinese. Stillbirth rate ranged from 0.2% among Indonesians to 0.7% among aboriginal Taiwanese. Adjusted odds ratio (OR) was lower among mainland Chinese (preterm OR, 0.77; LBW OR, 0.62) but higher among aboriginal Taiwanese (preterm OR, 1.79; LBW OR, 2.68; stillbirth OR, 2.92). HBW rate was significantly higher (OR, 1.84) among mainland Chinese. Chinese-speaking immigrants showed significant differences in LBW (OR, 0.57) and HBW (OR, 1.62) compared with non-Chinese-speaking immigrants.

Conclusion: An epidemiologic paradox and heterogeneity of birth outcomes were observed among immigrants in this study. However, aboriginal Taiwanese constituted the subgroup with the highest risk. Further research is needed to identify the determinants of birth outcomes. [*J Formos Med Assoc* 2008;107(10): 782–790]

Key Words: ethnicity, immigrants, low birth weight, preterm

As in Western countries, Taiwan has seen an increase in immigration from developing countries during the last decade. Most of the immigrant women were from mainland China, Indonesia and Vietnam and they represented 12% of all mothers in Hsin-Chu County, Taiwan. Among these, mainland Chinese use the same language, Chinese, as do native Taiwanese.

Several studies have documented low rates of low birth weight (LBW) among immigrant women of low socioeconomic status. This phenomenon has been termed the *epidemiologic paradox*.[1–6] Although Asians are often regarded as a single ethnic group, they are in fact heterogeneous, and multiethnic variations are found in culture, religion, language, and country of origin.

[1]Community Medicine Research Center and Institute of Public Health, National Yang-Ming University, Taipei, and [2]Public Health Bureau of Hsin-Chu County, Taiwan.

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***Correspondence to:** Dr Pesus Chou, Community Medicine Research Center and Institute of Public Health, National Yang Ming University, Shih-Pai, Taipei 112, Taiwan.
E-mail: pschou@ym.edu.tw

However, information on birth outcomes among Asian immigrants has been limited, especially with regard to specific ethnic groups.[7–14]

In 2001, Taiwan computerized the National Birth Registration System. It is a mandatory reporting system with a reporting rate of over 99%. With this comprehensive information system, analysis of the data provided information on neonatal outcomes of immigrants. This study included all pregnant women residing in Hsin-Chu County, Taiwan, that gave birth between January 1, 2002 and July 31, 2007. A total of 30,770 computerized singleton birth certificate files were analyzed. Three critical issues concerning birth outcomes in Hsin-Chu County, Taiwan were examined: (1) whether immigrant status conferred a protective effect on birth outcomes; (2) whether any protective effect varied across racial/ethnic subgroups; and (3) whether the effect of immigrant status varied with socioeconomic status, such as maternal language,[15–17] within different immigrant subgroups. In addition to immigrants, an aboriginal subgroup was also studied.

To provide additional insight into racial disparities, five models were designed for various logistic analyses to compare the impact of race/ethnicity and maternal language on birth outcomes. The birth outcomes included preterm birth (< 37 weeks), low birth weight (LBW, < 2500 g), high birth weight (HBW, > 4000 g) and stillbirth. The effect of risk factors (maternal age,[18] year of delivery, medical care institution, mode of delivery, infant sex, congenital birth defects) on birth outcomes was also evaluated. Moreover, because language is a crucial force during the acculturative process in immigrants, the impact of maternal language on birth outcomes was also evaluated for both Chinese-speaking and non-Chinese-speaking immigrants.

Methods

All pregnant women residing in Hsin-Chu County, Taiwan who gave birth between January 1, 2002 and July 31, 2007 were recruited. We used birth certificates compiled by the National Birth Registration System. A total of 30,770 singleton births born to mainland Chinese, Indonesian, Vietnamese, aboriginal Taiwanese and non-aboriginal Taiwanese women were analyzed. The outcome variables in this study were preterm (< 37 weeks), LBW (< 2500 g), HBW (> 4000 g), and stillbirth. The predictor variable of primary interest was maternal race/ethnicity.

Age-specific analyses of preterm birth, LBW, HBW and stillbirth rates provided a cross-sectional view of birth outcomes across the childbearing years, stratified by ethnicity. Sequential modeling by multiple logistic regression analysis was employed to compute odds ratios (ORs) and 95% confidence intervals (CIs) for estimating the relationship between maternal characteristics and birth outcomes. A p value ≤ 0.05 was set as significant. All covariates derived from Hsin-Chu County birth certificate data for use in these models were risk factors for birth outcomes. They included maternal age, year of delivery, mode of delivery (vaginal delivery, cesarean delivery), medical care institution (hospital, clinic), infant sex and congenital birth defects.

A central issue in immigrant health studies is the choice of an appropriate reference group. To compare the impact of race/ethnicity and maternal language on birth outcomes, five models were designed. The reference categories were defined by immigrant status, maternal language and nativity. They were non-immigrant, non-aboriginal Taiwanese and non-Chinese-speaking immigrants. All covariates mentioned above were controlled from Model 1 to Model 5. Model 5 was designed to examine further whether the effect on birth outcomes varied with maternal language among different immigrant subgroups.

Results

Among the total of 30,770 cases, the proportion of different ethnic subgroups were mainland Chinese, 4.8% ($n = 1483$); Indonesian, 3.6% ($n = 1129$); Vietnamese, 3.5% ($n = 1081$); aboriginal

Table 1. Demographic characteristics by maternal ethnicity among Hsin-Chu County resident singleton births, Taiwan, 2002–2007*

	Mainland Chinese ($n=1483$)	Indonesian ($n=1129$)	Vietnamese ($n=1081$)	Aboriginal Taiwanese ($n=1226$)	Non-aboriginal Taiwanese ($n=25,851$)
Maternal age (yr)					
<20	5 (0.3)	96 (8.5)	116 (10.8)	199 (16.2)	782 (3.0)
20–24	386 (26.1)	559 (49.6)	559 (52.0)	429 (35.0)	4066 (15.8)
25–29	653 (44.2)	332 (29.5)	305 (28.4)	357 (29.1)	9814 (38.1)
30–34	342 (23.2)	101 (9.0)	73 (6.8)	154 (12.6)	8256 (32.0)
35–39	79 (5.3)	29 (2.6)	22 (2.0)	69 (5.6)	2545 (9.9)
≥40	12 (0.8)	9 (0.8)	0 (0.0)	17 (1.4)	309 (1.2)
Year of delivery					
2002	270 (18.2)	260 (23.0)	178 (16.5)	256 (20.9)	4867 (18.8)
2003	246 (16.6)	211 (18.7)	174 (16.1)	223 (18.2)	4213 (16.3)
2004	267 (18.0)	237 (21.0)	196 (18.1)	229 (18.7)	4647 (18.0)
2005	266 (17.9)	195 (17.3)	230 (21.3)	212 (17.3)	4505 (17.4)
2006	285 (19.2)	144 (12.8)	203 (18.8)	204 (16.6)	4826 (18.7)
2007	149 (10.0)	82 (7.3)	100 (9.3)	102 (8.3)	2793 (10.8)
Medical care institutions					
Hospital	942 (63.5)	587 (52.0)	566 (52.4)	818 (66.7)	17,916 (69.3)
Clinic	541 (36.5)	542 (48.0)	515 (47.6)	408 (33.3)	7935 (30.7)
Mode of delivery					
Cesarean section	326 (22.0)	181 (16.0)	184 (17.0)	336 (27.4)	7692 (29.8)
Vaginal birth	1157 (78.0)	948 (84.0)	897 (83.0)	890 (72.6)	18,158 (70.2)
Infant sex					
Male	784 (52.9)	583 (51.6)	540 (50.0)	643 (52.4)	13,571 (52.5)
Female	699 (47.1)	546 (48.4)	541 (50.0)	583 (47.6)	12,274 (47.5)
Congenital birth defect					
Abnormal	7 (0.5)	7 (0.6)	2 (0.2)	11 (0.9)	169 (0.7)
Normal	1476 (99.5)	1122 (99.4)	1079 (99.8)	1215 (99.1)	25,283 (99.3)

**Data presented as n (%).*

Taiwanese, 3.9% ($n=1226$); and non-aboriginal Taiwanese, 82.9% ($n=25,851$).

Maternal demographic characteristics and birth outcome rates

The mean age distribution of the subgroups studied was as follows: mainland Chinese, 27.6±4.2 years; Indonesian, 24.7±4.3 years; Vietnamese, 24.0±3.8 years; aboriginal Taiwanese, 25.2±5.4 years; and non-aboriginal Taiwanese, 28.8±4.7 years.

Table 1 shows the distribution of demographic factors for the study population by race/ethnicity. As can be seen, there are substantial age differences among the various study subgroups. Compared with non-aboriginal Taiwanese women, the majority of Indonesian and Vietnamese immigrant women were in the 20–24 years age category (49.6% and 52%, respectively), with the proportion of births declining steadily over childbearing years. On the other hand, there were relatively more aboriginal Taiwanese and non-aboriginal Taiwanese in the age categories of <20 (16.2%) and 30–34 (32.0%) years.

Table 2 shows the crude rates of birth outcomes by race/ethnicity and maternal age category. Overall, the preterm rates were: mainland Chinese, 6.3% (93/1483); Indonesian, 6.2% (70/1129); Vietnamese, 7.7% (82/1081); aboriginal Taiwanese, 13.5% (166/1226); and non-aboriginal Taiwanese,

Table 2. Birth outcomes by maternal ethnicity and age among Hsin-Chu County resident singleton births, Taiwan, 2002–2007*

	Mainland Chinese	Indonesian	Vietnamese	Aboriginal Taiwanese	Non-aboriginal Taiwanese
Preterm (< 37 wk)					
< 20	0 (0.0)	3 (3.1)	7 (6.0)	24 (12.1)	87 (11.1)
20–24	24 (6.2)	37 (6.6)	37 (6.6)	57 (13.3)	326 (8.0)
25–29	40 (6.1)	22 (6.6)	23 (7.5)	52 (14.6)	717 (7.3)
30–34	17 (5.0)	7 (6.9)	12 (16.4)	15 (9.7)	784 (9.5)
35–39	7 (8.9)	0 (0.0)	3 (13.6)	12 (17.4)	248 (9.7)
≥ 40	5 (41.7)	1 (11.1)	0 (0.0)	6 (35.5)	57 (18.4)
All	93 (6.3)	70 (6.2)	82 (7.7)	166 (13.5)	2230 (8.6)
Low birth weight (< 2500 g)					
< 20	0 (0.0)	5 (5.2)	7 (6.0)	40 (20.1)	88 (11.3)
20–24	18 (4.7)	28 (5.0)	32 (5.7)	68 (15.9)	337 (8.3)
25–29	26 (4.0)	20 (6.0)	23 (7.5)	60 (16.8)	619 (6.3)
30–34	11 (3.2)	6 (5.9)	9 (12.3)	21 (13.6)	565 (6.8)
35–39	6 (7.6)	1 (3.4)	1 (4.5)	18 (26.1)	195 (7.7)
≥ 40	3 (25.0)	4 (44.4)	0 (0.0)	5 (29.4)	39 (12.6)
All	64 (4.3)	64 (5.7)	72 (6.7)	212 (17.3)	1851 (7.2)
High birth weight (> 4000 g)					
< 20	0 (0.0)	2 (2.1)	2 (1.7)	1 (0.0)	3 (0.4)
20–24	11 (2.8)	4 (0.7)	7 (1.3)	3 (0.7)	57 (1.4)
25–29	20 (3.1)	8 (2.4)	7 (2.3)	9 (2.5)	181 (1.8)
30–34	11 (3.2)	2 (2.0)	0 (0.0)	1 (0.6)	198 (2.4)
35–39	8 (10.1)	1 (3.4)	0 (0.0)	1 (1.4)	87 (3.4)
≥ 40	0 (0.0)	2 (22.2)	0 (0.0)	1 (5.9)	13 (4.2)
All	50 (3.4)	19 (1.7)	16 (1.5)	15 (1.2)	540 (2.1)
Stillbirth					
< 20	0 (0.0)	0 (0.0)	1 (0.9)	5 (2.5)	10 (1.3)
20–24	3 (0.8)	1 (0.2)	0 (0.0)	3 (0.7)	22 (0.5)
25–29	2 (0.3)	0 (0.0)	1 (0.3)	7 (2.0)	51 (0.5)
30–34	2 (0.6)	1 (1.0)	0 (0.0)	1 (0.6)	71 (0.9)
35–39	1 (1.3)	0 (0.0)	0 (0.0)	3 (4.3)	25 (1.0)
≥ 40	1 (8.3)	0 (0.0)	0 (0.0)	2 (11.8)	7 (2.3)
All	9 (0.6)	2 (0.2)	2 (0.2)	21 (1.7)	188 (0.7)

**Data presented as n (%).*

8.6% (2230/25,851). The rates of LBW were: mainland Chinese, 4.3% (64/1483); Indonesian, 5.7% (64/1129); Vietnamese, 6.7% (72/1081); aboriginal Taiwanese, 17.3% (212/1226); and non-aboriginal Taiwanese, 7.2% (1851/25,851). The rates of HBW were: mainland Chinese, 3.4% (50/1483); Indonesian, 1.7% (19/1129); Vietnamese, 1.5% (16/1081); aboriginal Taiwanese, 1.2% (15/1226); and non-aboriginal Taiwanese, 2.1% (540/25,851). The rates of stillbirth were: mainland Chinese, 0.6% (9/1483); Indonesian, 0.2% (2/1129); Vietnamese, 0.2% (2/1081); aboriginal Taiwanese, 1.7% (21/1226); and non-aboriginal Taiwanese, 0.7% (188/25,851). As can be seen, there was no apparent increase in birth outcomes with advancing maternal age for any ethnic subgroup.

Effect of race/ethnicity and maternal age on birth outcomes

Table 3 shows the result of Model 1 obtained by multiple logistic analyses. In this model, the study sample was divided into five subgroups according to race/ethnicity, including mainland Chinese, Indonesian, Vietnamese, non-aboriginal Taiwanese

Table 3. Logistic regression analysis on birth outcomes by maternal ethnicity and other demographic characteristics among Hsin-Chu County resident singleton births, Taiwan, 2002–2007

	Adjusted odds ratio (95% CI)			
	Preterm	LBW	HBW	Stillbirth
Ethnicity				
Mainland Chinese	0.77 (0.62–0.95)	0.62 (0.48–0.80)	1.84 (1.37–2.49)	0.91 (0.46–1.80)
Indonesian	0.83 (0.65–1.07)	0.84 (0.64–1.09)	1.13 (0.71–1.81)	0.33 (0.08–1.33)
Vietnamese	1.07 (0.85–1.35)	0.99 (0.78–1.28)	1.04 (0.62–1.73)	0.35 (0.09–1.45)
Aboriginal Taiwanese	1.79 (1.50–2.13)	2.68 (2.28–3.15)	0.78 (0.46–1.32)	2.92 (1.80–4.71)
Non-aboriginal Taiwanese	1.00	1.00	1.00	1.00
Maternal age (yr)	1.01 (1.01–1.02)	0.99 (0.98–1.00)	1.06 (1.04–1.08)	1.05 (1.02–1.08)
Year of delivery				
2007	1.19 (1.02–1.38)	1.17 (0.98–1.38)	0.95 (0.69–1.31)	5.73 (2.27–14.45)
2006	0.93 (0.81–1.06)	1.03 (0.89–1.20)	1.05 (0.81–1.35)	7.85 (3.36–18.39)
2005	0.94 (0.82–1.07)	1.09 (0.94–1.26)	0.91 (0.69–1.19)	8.24 (3.52–19.28)
2004	1.05 (0.92–1.20)	1.11 (0.96–1.28)	1.06 (0.82–1.37)	7.74 (3.31–18.11)
2003	0.98 (0.86–1.13)	1.05 (0.90–1.21)	1.11 (0.86–1.45)	6.13 (2.56–14.67)
2002	1.00	1.00	1.00	1.00
Medical care institutions				
Hospital	1.30 (1.19–1.43)	1.34 (1.21–1.48)	0.67 (0.57–0.79)	1.84 (1.28–2.65)
Clinic	1.00	1.00	1.00	1.00
Mode of delivery				
Cesarean section	1.56 (1.43–1.70)	1.47 (1.34–1.62)	3.02 (2.57–3.56)	0.49 (0.35–0.70)
Vaginal birth	1.00	1.00	1.00	1.00
Infant sex				
Male	1.18 (1.08–1.28)	0.78 (0.72–0.85)	1.87 (1.58–2.21)	0.90 (0.68–1.19)
Female	1.00	1.00	1.00	1.00
Congenital birth defect				
Abnormal	4.63 (3.40–6.30)	6.56 (4.84–8.90)	0.33 (0.05–2.39)	28.55 (18.80–43.36)
Normal	1.00	1.00	1.00	1.00

and aboriginal Taiwanese. After controlling for all covariates, race/ethnicity was found to be a significant predictor of preterm birth (OR, 0.77; 95% CI, 0.62–0.95) and LBW (OR, 0.62; 95% CI, 0.48–0.80) among mainland Chinese. In aboriginal Taiwanese, the figures were OR, 1.79 and 95% CI, 1.50–2.13 for preterm birth and OR, 2.68 and 95% CI 2.28–3.15 for LBW. Meanwhile, the mainland Chinese subgroup had the highest rate of HBW with statistical significance (OR, 1.84; 95% CI, 1.37–2.49).

After adjustment for the effects of other risk factors, maternal age (continuous variable) remained a significant predictor. Older women were at increased risk for preterm (OR, 1.01; 95% CI, 1.01–1.02), HBW (OR, 1.06; 95% CI, 1.04–1.08) and stillbirth (OR, 1.05; 95% CI, 1.02–1.08). Infant boys were more likely to be preterm (OR, 1.18; 95% CI, 1.08–1.28) or HBW (OR, 1.87; 95% CI, 1.58–2.21) than infant girls. In addition, infant boys had a significantly lower rate of LBW (OR, 0.78; 95% CI, 0.72–0.85).

To explore the effect of maternal age on birth outcomes, age stratification (< 20, 20–24, 25–29, 30–34, 35–39, ≥ 40 years) was carried out for logistic regression analyses. It showed significant results in various strata: (1) preterm birth: mainland Chinese (30–34 years: OR, 0.53; 95% CI, 0.33–0.88), Indonesian (< 20 years: OR, 0.28; 95% CI, 0.09–0.93), Vietnamese (30–34 years: OR,

Table 4. Logistic regression models for birth outcomes by maternal ethnicity and other demographic characteristics among Hsin-Chu County resident singleton births, Taiwan, 2002–2007

	Adjusted odds ratio* (95% CI)			
	Preterm	LBW	HBW	Stillbirth
Model 1: Mainland Chinese, Indonesian, Vietnamese, Aboriginal Taiwanese, Non-aboriginal Taiwanese				
Mainland Chinese	0.77 (0.62–0.95)	0.62 (0.48–0.80)	1.84 (1.37–2.49)	0.91 (0.46–1.80)
Indonesian	0.83 (0.65–1.07)	0.84 (0.64–1.09)	1.13 (0.71–1.81)	0.33 (0.08–1.33)
Vietnamese	1.07 (0.85–1.35)	0.99 (0.78–1.28)	1.04 (0.62–1.73)	0.35 (0.09–1.45)
Aboriginal Taiwanese	1.79 (1.50–2.13)	2.68 (2.28–3.15)	0.78 (0.46–1.32)	2.92 (1.80–4.71)
Non-aboriginal Taiwanese	1.00	1.00	1.00	1.00
Model 2: Chinese immigrant, Non-Chinese immigrant, Aboriginal Taiwanese, Non-aboriginal Taiwanese				
Chinese immigrant	0.77 (0.62–0.95)	0.62 (0.48–0.80)	1.84 (1.37–2.49)	0.91 (0.46–1.80)
Non-Chinese immigrant	0.95 (0.79–1.13)	0.91 (0.76–1.10)	1.09 (0.76–1.55)	0.34 (0.12–0.93)
Aboriginal Taiwanese	1.79 (1.50–2.13)	2.68 (2.28–3.15)	0.78 (0.46–1.32)	2.91 (1.80–4.71)
Non-aboriginal Taiwanese	1.00	1.00	1.00	1.00
Model 3: Chinese immigrant, Non-Chinese immigrant, Non-immigrant				
Chinese immigrant	0.74 (0.60–0.92)	0.58 (0.45–0.74)	1.86 (1.38–2.51)	0.84 (0.43–1.66)
Non-Chinese immigrant	0.90 (0.76–1.07)	0.82 (0.68–0.99)	1.10 (0.77–1.57)	0.31 (0.11–0.83)
Non-immigrant	1.00	1.00	1.00	1.00
Model 4: Immigrant, Non-immigrant				
Immigrant	0.83 (0.72–0.96)	0.72 (0.62–0.84)	1.46 (1.15–1.85)	0.55 (0.31–0.97)
Non-immigrant	1.00	1.00	1.00	1.00
Model 5: Chinese-speaking immigrant, Non-Chinese-speaking immigrant				
Chinese-speaking immigrant	0.77 (0.58–1.03)	0.57 (0.41–0.80)	1.62 (1.01–2.60)	2.97 (0.79–11.20)
Non-Chinese-speaking immigrant	1.00	1.00	1.00	1.00

**Adjusted for maternal age, year of delivery, medical institutions, mode of delivery, infant sex and congenital birth defect.*

2.09; 95% CI, 1.11–3.93), aboriginal Taiwanese (20–24 years: OR, 1.66; 95% CI, 1.22–2.25; 25–29 years: OR, 2.18; 95% CI, 1.60–2.96); (2) LBW: mainland Chinese (20–24 years: OR, 0.57; 95% CI, 0.35–0.93; 25–29 years: OR, 0.65; 95% CI, 0.43–0.97; 30–34 years: OR, 0.49; 95% CI, 0.27–0.90), Indonesian (20–24 years: OR, 0.62; 95% CI, 0.41–0.92; ≥40 years: OR, 9.94; 95% CI, 1.94–50.85), Vietnamese (30–34 years: OR, 2.06; 95% CI, 1.01–4.18), non-aboriginal Taiwanese (<20 years: OR, 1.90; 95% CI, 1.24–2.90; 20–24 years: OR, 1.98; 95% CI, 1.49–2.64; 25–29 years: OR, 3.01; 95% CI, 2.25–4.05; 30–34 years: OR, 2.27; 95% CI, 1.41–3.64; 35–39 years: OR, 4.09; 95% CI, 2.30–7.28); (3) HBW: mainland Chinese (20–24 years: OR, 2.07; 95% CI, 1.06–4.03; 25–29 years: OR, 1.73; 95% CI, 1.08–2.78; 35–39 years: OR, 3.39; 95% CI, 1.53–7.47), Indonesian (≥40 years: OR, 30.36; 95% CI, 3.32–277.50); (4) stillbirth: aboriginal Taiwanese (25–29 years: OR, 4.46; 95% CI, 1.93–10.33; 35–39 years: OR, 4.60; 95% CI, 1.26–16.84; ≥40 years: OR, 5.38; 95% CI, 1.06–27.40).

Effect of race/ethnicity and maternal language on birth outcomes

Table 4 shows the adjusted ORs of multiple logistic analyses from Model 1 to Model 5. In Model 2, we further divided the study group into four subgroups, including Chinese immigrants (mainland Chinese), non-Chinese immigrants (Indonesian and Vietnamese), aboriginal Taiwanese and non-aboriginal Taiwanese. The reference category was non-aboriginal Taiwanese. The results showed significantly low rates of preterm birth (OR, 0.77; 95% CI, 0.62–0.95) and LBW (OR, 0.62; 95% CI, 0.48–0.80), but a high rate of HBW (OR, 1.84; 95% CI, 1.37–2.49) among Chinese immigrant

women. Non-Chinese immigrants showed a significantly low rate of stillbirth (OR, 0.34; 95% CI, 0.12–0.93). Aboriginal Taiwanese were found to have a significantly high risk of preterm birth (OR, 1.79; 95% CI, 1.50–2.13), LBW (OR, 2.68; 95% CI, 2.28–3.15) and stillbirth (OR, 2.91; 95% CI, 1.80–4.71).

In Model 3, we classified the study group into Chinese immigrant, non-Chinese immigrant and non-immigrant (aboriginal and non-aboriginal Taiwanese) subgroups. Compared with the non-immigrant subgroup, the Chinese immigrants revealed significantly low rates of preterm birth (OR, 0.74; 95% CI, 0.60–0.92) and LBW (OR, 0.58; 95% CI, 0.45–0.74) and a high rate of HBW (OR, 1.86; 95% CI, 1.38–2.51). The non-Chinese immigrant subgroup showed a significantly low rate of LBW (OR, 0.82; 95% CI, 0.68–0.99) and stillbirth (OR, 0.31; 95% CI, 0.11–0.83).

In Model 4, we classified the study group into immigrant (mainland Chinese, Indonesian and Vietnamese) and non-immigrant subgroups. The latter was taken as the reference category. All immigrant women showed significantly low rates of preterm birth (OR, 0.83; 95% CI, 0.72–0.96), LBW (OR, 0.72; 95% CI, 0.62–0.84) and stillbirth (OR, 0.55; 95% CI, 0.31–0.97). Furthermore, the HBW rate was significantly higher (OR, 1.46; 95% CI, 1.15–1.85) in the immigrant subgroup.

Table 4 also shows the results of Model 5. In this model, we classified the study group according to maternal language among immigrant subgroups. There were Chinese-speaking immigrant (mainland Chinese) and non-Chinese-speaking immigrant (Indonesian and Vietnamese) subgroups. Compared with the latter, the Chinese-speaking immigrant subgroup had a lower rate of LBW (OR, 0.57; 95% CI, 0.41–0.80) and a higher rate of HBW (OR, 1.62; 95% CI, 1.01–2.60).

Discussion

Taiwan has seen an increase in immigration from developing countries during the last decade. Most of the immigrant women were from mainland China, Indonesia and Vietnam. Although Asians are often regarded as a single ethnic group, they are in fact heterogeneous, with multiethnic variations in culture, religion, language, and country of origin. Among them, mainland Chinese and native Taiwanese use the same language, Chinese.

Several studies have documented the epidemiologic paradox, that is, low rates of LBW among immigrant women of low socioeconomic status. In this study, the study population was classified into five subgroups, mainland Chinese, Indonesian, Vietnamese, aboriginal Taiwanese and non-aboriginal Taiwanese. As with native Indians in the United States, aboriginal Taiwanese are referred to as the indigenous inhabitants of Taiwan in contrast to the Han immigrants from China. They have been living on the island for thousands of years. Most of them live in the mountains and have low socioeconomic status. As mentioned above, a central issue in immigrant health studies is the choice of an appropriate reference group. We set different reference groups in various models according to immigrant status, nativity and maternal language. The following are the five main findings of this study: (1) immigrant status does have a protective effect on birth outcomes, including preterm birth, LBW and stillbirth; (2) this protective effect varies considerably across racial/ethnic subgroups; (3) immigrants, especially mainland Chinese women, have a significantly higher rate of HBW; (4) the effect of birth outcomes varies with maternal language among immigrants; (5) aboriginal status has an adverse effect on birth outcomes in Taiwanese women.

With increasing maternal age, there were significantly increasing rates of preterm birth, HBW and stillbirth. Considering the effect of maternal age[18] on ethnic birth outcomes, we stratified age for serial logistic regression analyses. Restricted by the limited sample size, the rates and ORs did not increase steadily over the childbearing years among various subgroups, indicating no significant effect of maternal age.

In line with prior research, this study also found evidence for the epidemiologic paradox among immigrant subgroups. In Model 4, compared

with the non-immigrant subgroup, the immigrant subgroup showed a significantly lower risk of preterm birth, LBW and stillbirth, and a higher risk of HBW. Although we cannot evaluate whether cultural factors, education, birth order and other unmeasured risk factors for birth outcomes influenced the results, one plausible explanation is that immigrant women may be selected owing to their sound health status. Moreover, utilization of prenatal care was documented to be strongly associated with birth outcomes.[8] In Taiwan, the high coverage rate of the National Health Insurance Program might narrow the gap of utilization of prenatal care and enhance the positive effect for immigrants.

For heterogeneous ethnic groups such as Asians, it is important to analyze subgroups separately, because there may be variations in health outcomes.[8] Our results also demonstrated that there was a great deal of variation in birth outcomes among immigrant subgroups. Such heterogeneity merits further investigation. Mainland Chinese women showed significantly lower rates of preterm birth and LBW, and a higher rate of HBW. HBW is a new issue of concern to researchers.[19–21] The maternal language used by the mainland Chinese subgroup[16–18] may have been advantageous to them to overcome the problems encountered in the process of acculturation. A similar maternal language (Chinese) and diet may be beneficial to mainland Chinese immigrants, contributing to the lower rate of LBW and higher rate of HBW. Furthermore, health beliefs may be another factor. According to traditional Chinese culture, a chubby baby is a symbol of good health and fortune. This kind of belief may account for the higher rate of HBW among mainland Chinese women obtained in Model 5. The impact of maternal language,[16–18] i.e. the importance of maternal language in the process of acculturation for immigrant women, merits further research. Meanwhile, the reasons behind the significantly higher rate of HBW among the mainland Chinese subgroup are also worth more in-depth exploration. Indonesian and Vietnamese immigrant women did not show specific healthy immigrant effects in this study. After integrating those two subgroups into the group of non-Chinese immigrants, the result showed a significantly low risk of LBW and stillbirth. The small number of cases in each subgroup was a limitation of this study.

Results obtained regarding the aboriginal subgroup were consistent with previous findings. The aboriginal Taiwanese women showed a high risk of preterm birth, LBW and stillbirth. On average, aboriginal women faced more adverse socioeconomic factors (e.g. low education, low income, poor nutrition, smoking and drinking during pregnancy) than non-aboriginal Taiwanese women.

This study describes a birth outcome pattern of immigrant pregnant women in Hsin-Chu County, Taiwan. There were statistically significant variations in birth outcomes by race/ethnicity, nativity, and maternal language. Immigrant status had a protective effect on birth outcomes, i.e. preterm birth, LBW and stillbirth. Moreover, a significantly high rate of HBW was found among the mainland Chinese subgroup. Maternal language also had a positive effect on birth outcomes. Although the present data did not allow us to examine the mechanisms underlying the above variations, our analysis suggests topics for future research in relation to the role of health beliefs, cultural factors and social determinants. The need to implement efficient strategies to promote maternal and child health among aborigines is also urgent.

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References

1. Rosenberg TJ, Raggio TP, Chiasson MA. A further examination of the "epidemiologic paradox": birth outcomes among Latinas. *J Natl Med Assoc* 2005;97:550–6.
2. Auger N, Luo ZC, Platt RW, et al. Do mother's education and foreign born status interact to influence birth outcomes? Clarifying the epidemiological paradox and the healthy

migrant effect. *J Epidemiol Community Health* 2008;62: 402–9.
3. Frank R. International migration and infant health in Mexico. *J Immigr Health* 2005;7:11–22.
4. Page RL. Positive pregnancy outcomes in Mexican immigrants: what can we learn? *J Obstet Gynecol Neonatal Nurs* 2004;33:783–90.
5. Gould JB, Madan A, Qin C, et al. Perinatal outcomes in two dissimilar immigrant populations in the United States: a dual epidemiologic paradox. *Pediatrics* 2003;111: e676–82.
6. Fuentes-Afflick E, Hessol NA, Perez-Stable EJ. Testing the epidemiologic paradox of low birth weight in Latinos. *Arch Pediatr Adolesc Med* 1999;153:147–53.
7. Qin C, Gould JB. The Asian birth outcome gap. *Paediatr Perinat Epidemiol* 2006;20:279–89.
8. Fuentes-Afflick E, Hessol NA. Impact of Asian ethnicity and national origin on infant birth weight. *Am J Epidemiol* 1997;145:148–55.
9. Sullivan JR, Shepherd SJ. Obstetric outcomes and infant birthweights for Vietnamese-born and Australian-born women in southwestern Sydney. *Aust N Z J Public Health* 1997;21:159–62.
10. Rundle D, Barclay L, Nivison-Smith I, et al. Maternal country of origin and infant birthplace: implications for birth-weight. *Aust N Z J Obstet Gynaecol* 1996;36: 430–4.
11. Sullivan JR, Shepherd SJ. Obstetric outcomes and infant birthweights for Vietnamese-born and Australian-born women in southwestern Sydney. *Aust N Z J Public Health* 1997;21:159–62.
12. Le LT, Kiely JL, Schoendorf KC. Birthweight outcomes among Asian American and Pacific Islander subgroups in the United States. *Int J Epidemiol* 1996;25:973–9.
13. Singh GK, Yu SM. Adverse pregnancy outcomes: differences between US- and foreign-born women in major US racial and ethnic groups. *Am J Public Health* 1996;86:837–43.
14. Acevedo-Garcia D, Soobader MJ, Berkman LF. The differential effect of foreign-born status on low birth weight by race/ethnicity and education. *Pediatrics* 2005;115:e20–30.
15. Ngo-Metzger Q, Massagli MP, Clarridge BR, et al. Linguistic and cultural barriers to care. *J Gen Intern Med* 2003;18: 44–52.
16. Bischoff A, Perneger TV, Bovier PA, et al. Improving communication between physicians and patients who speak a foreign language. *Br J Gen Pract* 2003;53:541–6.
17. Green AR, Ngo-Metzger Q, Legedza AT, et al. Interpreter services, language concordance, and health care quality. Experiences of Asian Americans with limited English proficiency. *J Gen Intern Med* 2005;20:1050–6.
18. Rauh VA, Andrews HF, Garfinkel RS. The contribution of maternal age to racial disparities in birthweight: a multilevel perspective. *Am J Public Health* 2001;91:1815–24.
19. Vangen S, Stoltenberg C, Skjaerven R, et al. The heavier the better? Birthweight and perinatal mortality in different ethnic groups. *Int J Epidemiol* 2002;31:654–60.
20. Buekens P, Masuy-Stroobant G, Delvaux T. High birthweights among infants of north African immigrants in Belgium. *Am J Public Health* 1998;88:808–11.
21. Yudkin PL, Harlap S, Baras M. High birthweight in an ethnic group of low socioeconomic status. *Br J Obstet Gynaecol* 1983;90:291–6.